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Attosecond pulse formation via switching of resonant interaction by tunnel ionization

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Abstract

© 2015 American Physical Society. We derive an analytical solution uncovering the origin of few-cycle attosecond pulse formation from vacuum-ultraviolet (VUV) radiation in an atomic gas simultaneously irradiated by a moderately strong infrared (IR) laser field, which does not perturb atoms in the ground state, but induces rapid quasistatic ionization from the excited states [Polovinkin, Opt. Lett. 36, 2296 (2011)10.1364/OL.36.002296]. The derived solution shows that the pulses are produced due to periodic switching of the resonant interaction between the incident VUV radiation and the atoms: turning it off near the crests of the IR-field strength and switching it back on near the IR-field zero crossings. We extend the method originally proposed by Polovinkin [Opt. Lett. 36, 2296 (2011)10.1364/OL.36.002296] to non-hydrogen-like media and show that the pulses can be produced from resonant VUV radiation in a variety of atomic gases. The pulses are nearly bandwidth limited without external adjustment of phases of the generated sidebands. Proximity of the carrier frequency of the produced pulses to intra-atomic resonances may allow their efficient utilization for nondestructive steering of ultrafast dynamics of the bound electrons. The experimental possibilities for attosecond pulse formation from 58.4 nm VUV radiation in helium and from 73.6 nm VUV radiation in neon dressed by the 3.9 μm laser field, as well as from 122 nm VUV radiation in atomic hydrogen dressed by CO2-laser field are discussed.

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